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Identification of Downtime and its Consequences in Manufacturing Industries – An Exploratory Study in Readymade Garments Industries in Bangladesh

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Abstract: *The dynamic change in market demand and the changes in customer expectation over quality, price and availability of product force the manufacturing organizations to makes their production processes flexible enough to cope up with those changes. However, manufacturing organizations are encountering daily some parameters who don't add value in their business operations. Some parameters cause significant problem to the organizations in terms of production loss, property loss, monetary loss and above all business loss. The real challenge for those organizations is to keep their operations interruption-free and to maintain smooth running of their business, which is a rare case. Therefore, the ultimate target for the organizations should be to minimize the non value addition time. This requires to having prior knowledge about the causes and consequences of typical parameters named downtime. In Bangladesh, the Ready-made Garments (RMG) Industry is playing an important role in national economy. The organizations of this sector need to ensure the smooth running of their business. But, their manufacturing systems are being interrupted by some big parameters, which result system down and doesn't add value. This research has been conducted with the aim of identifying typical parameters for whom the installation remain in down named system downtime. For this purpose, an exploratory and simulation study involving 31 organizations has been performed. This paper delineates the overall scenario of common parameters of downtime exist in the RMG sector and discusses the causes and consequences of those non value addition factors. The study has identified five big time losses (Factors). These are….*

- *Machine Breakdown;*
- *no input;*
- *Absenteeism;*
- *Scrap & rework;*
- *Miscellaneous (power problem, planning problem etc);*

According to our analysis (1) Machine Breakdown and (2) setup and adjustment were categorized as downtime time loss, reducing availability; (3) idling and minor stoppage and (4) reduced speed were categorized as speed loss, thus reducing performance. Finally, (5) defects in process and (6) reduced yields were considered as defect loss generated from low quality.

Some dominated are equipment Failure, defects in process and scrap and rework etc. From our observation, five big losses are responsible for some typical reason. Five causes are accountable for machine malfunctioning. Following some proposed strategies, the studied organizations could reduce the occurrences of some factors of time losses. The research concludes that the identified parameters of non value addition can be benchmarked by similar to organizational deal with to increase overall productivity.

Keyword: *Absenteeism, Downtime, Machine Breakdown, Scrap & rework*

I. INTRODUCTION

The Ready Made Garment (RMG) industries of Bangladesh have emerged as a major economic sector and as well as had its impact on the communication, transportation, financial service sector and on other related industries. At present 2 millions of garment workers are working in the RMG unit. Above 80 percent of this workers are female. RMG is the highest earning industry in the economy. RMG roughly covers 78 percent of the total export of the country. There are about 4000 RMG industry in the country and about one-fourth of the number of employees are directly engaged with manufacturing job. [1] The ready-made garment (RMG) industry of Bangladesh started in the late 1970s and became a prominent player in the economy within a short period of time. The industry has contributed to export earnings, foreign exchange earnings, employment creation, poverty alleviation and the empowerment of women. The export-quota system and the availability of cheap labour are the two main reasons behind the success of the industry. In the 1980s, the RMG industry of Bangladesh was concentrated mainly in manufacturing and exporting woven products. Since the early 1990s, the knit section of the industry has started to expand. Shirts, T-shirts, trousers, sweaters and jackets are the main products manufactured and exported by the industry. Bangladesh exports its RMG products mainly to the United States of America and the European Union. These two destinations account for more than a 90 per cent share of the country's total earnings from garment exports. The country has achieved some product diversification in both the United States and the European Union. Recently, the country has achieved some level of product upgrading in the European Union, but not to a significant extent in the United States. Bangladesh is less competitive compared with China or India in the United States and it is somewhat competitive in the European Union.

The phase-out of the export-quota system from the beginning of 2005 has raised the competitiveness issue of the Bangladesh RMG industry as a top priority topic.

The most important task for the industry is to reduce the lead time of garment manufacturing. The improvement of deep-level competitiveness through a reduction in total "Production and distribution" time will improve surface-level competitiveness by reducing lead time. Such a strategy is important for long-term stable development of the industry, but its implementation will take time. In contrast, the establishment of a central or common bonded warehouse will improve surface-level competitiveness by reducing lead time, but deep-level competitiveness will not be improved and long-term industry development will be delayed. Therefore, granting permission to establish in the private sector such warehouses with special incentives, such as the duty-free import of raw materials usable in the export-oriented garment industry for reducing the lead time in garment manufacturing is a critical issue for Bangladesh.[2]

On the other hand Bangladesh needs to improve the factory working environment and various social issues related to the RMG industry. International buyers are very particular about compliance with codes of conduct. Another aspect is issues related to product and market diversification as well as upgrading products needs to be addressed with special care. Moreover, the Government of Bangladesh needs to strengthen its support. The development of the port and other physical infrastructure, the smooth supply of utilities, a corruption-free business environment and political stability are some priority concerns for the Government to consider in its efforts to attract international buyers and investors.

II. Methodology

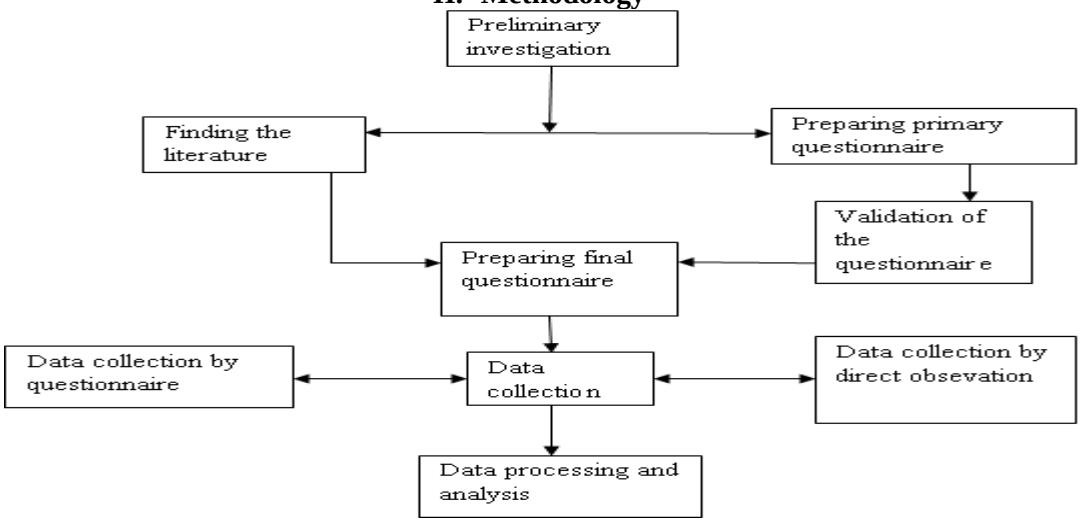

Figure 1: Overall steps of the research study

III. Analysis

3.1 Introduction

Analysis of data is a process of inspecting, cleaning, transforming, and modeling data with the goal of highlighting useful information, suggesting conclusions, and supporting decision making. Data analysis has multiple facets and approaches, encompassing diverse techniques under a variety of names, in different business, science, and social science domains.[16]

3.2 Type of data

Data can be of several types

- Quantitative data: data is a number
  - Often this is a continuous decimal number to a specified number of significant digits
  - Sometimes it is a whole http://en.wikipedia.org/wiki/Counting" \o "Counting" number
- Categorical data: data one of several categories
- http://en.wikipedia.org/wiki/Qualitative_data" \o "Qualitative data": data is a pass/fail or the presence or lack of a characteristic [17]

3.3 The process of data analysis

Data analysis is a process, within which several phases can be distinguished:

3.3.1 Data cleaning

Data cleaning is an important procedure during which the data are inspected, and erroneous data are—if necessary, preferable, and possible—corrected. Data cleaning can be done during the stage of data entry. If this is done, it is important that no subjective decisions are made. The guiding principle provided by Adèr (ref) is: during subsequent manipulations of the data, information should always be cumulatively retrievable. In other words, it should always be possible to undo any data set alterations.

3.3.2 Initial data analysis

The most important distinction between the initial data analysis phase and the main analysis phase, is that during initial data analysis one refrains from any analysis that are aimed at answering the original research question. The initial data analysis phase is guided by the following four questions:

3.3.3 Quality of data

The quality of the data should be checked as early as possible. Data quality can be assessed in several ways, using different types of analyses: frequency counts, descriptive statistics (mean, standard deviation, and median), normality (skewness, kurtosis, frequency histograms, normal probability plots), associations (correlations, scatter plots). Other initial data quality checks are:

- Checks on data cleaning: have decisions influenced the distribution of the variables? The distribution of the variables before data cleaning is compared to the distribution of the variables after data cleaning to see whether data cleaning has had unwanted effects on the data.
- Analysis of http://en.wikipedia.org/wiki/Missing_data" \o "Missing data observations: are there many missing values, and are the values http://en.wikipedia.org/wiki/MAR" \o "MAR"? The missing observations in the data are analyzed to see whether more than 25% of the values are missing, whether they are missing at random (MAR), and whether some form of http://en.wikipedia.org/wiki/ Imputation_%28statistics%29" \o "Imputation (statistics)" is needed.
- Analysis of http://en.wikipedia.org/wiki/Outlier" \o "Outlier": outlying observations in the data are analyzed to see if they seem to disturb the distribution.
- Comparison and correction of differences in coding schemes: variables are compared with coding schemes of variables external to the data set, and possibly corrected if coding schemes are not comparable.

The choice of analyses to assess the data quality during the initial data analysis phase depends on the analyses that will be conducted in the main analysis phase.

3.3.4 Quality of measurements

The quality of the http://en.wikipedia.org/wiki/Measuring_instrument" \o "Measuring instrument" should only be checked during the initial data analysis phase when this is not the focus or research question of the study. One should check whether structure of measurement instruments corresponds to structure reported in the literature. There are two ways to assess measurement quality:

- Confirmatory factor analysis
- Analysis of homogeneity (http://en.wikipedia.org/wiki/Internal_consistency" \o "Internal consistency"), which gives an indication of the http://en.wikipedia.org/wiki/Reliability_%28statistics%29" \o "Reliability (statistics)" of a measurement instrument. During this analysis, one inspects the variances of the items and the scales, the http://en.wikipedia.org/wiki/Cronbach%27s_alpha" \o "Cronbach's alpha" of the scales, and the change in the Cronbach's alpha when an item would be deleted from a scale.

3.3.5 Initial transformations

After assessing the quality of the data and of the measurements, one might decide to impute missing data, or to perform initial transformations of one or more variables, although this can also be done during the main analysis phase. Possible transformations of variables are:

- Square root transformation (if the distribution differs moderately from normal)
- Log-transformation (if the distribution differs substantially from normal)
- Inverse transformation (if the distribution differs severely from normal)
- Make categorical (ordinal / dichotomous) (if the distribution differs severely from normal, and no transformations help)

Did the implementation of the study fulfill the intentions of the research design?
One should check the success of the (http://en.wikipedia.org/wiki/Randomization" \o "Randomization") procedure, for instance by checking whether background and substantive variables are equally distributed within and across groups. If the study did not need and/or use a randomization procedure, one should check the success of the non-random sampling, for instance by checking whether all subgroups of the population of interest are represented in sample. Other possible data distortions that should be checked are:

- http://en.wikipedia.org/wiki/Dropout_%28electronics%29" \o "Dropout (electronics)" (this should be identified during the initial data analysis phase)
- Item http://en.wikipedia.org/wiki/Response_rate" \o "Response rate" (whether this is random or not should be assessed during the initial data analysis phase)
- Treatment quality (using http://en.wikipedia.org/w/index.php?title=Manipulation_check&action=edit &redlink=1"\o"Manipulation check (page does not exist)").

3.3.6 Characteristics of data sample

In any report or article, the structure of the sample must be accurately described. It is especially important to exactly determine the structure of the sample (and specifically the size of the subgroups) when subgroup analyses will be performed during the main analysis phase.

The characteristics of the data sample can be assessed by looking at:

- Basic statistics of important variables
- Scatter plots
- Correlations
- Cross-tabulations

3.3.7 Final stage of the initial data analysis

During the final stage, the findings of the initial data analysis are documented, and necessary, preferable, and possible corrective actions are taken. Also, the original plan for the main data analyses can and should be specified in more detail and/or rewritten. In order to do this, several decisions about the main data analyses can and should be made:

- In the case of non-normal's: should one http://en.wikipedia.org/wiki/Data_transformation _%28statistics%29" \o "Data transformation (statistics)" variables; make variables categorical (ordinal/dichotomous); adapt the analysis method?
- In the case of http://en.wikipedia.org/wiki/Missing_data" \o "Missing data": should one neglect or impute the missing data; which imputation technique should be used?
- In the case of http://en.wikipedia.org/wiki/Outlier" \o "Outlier": should one use robust analysis techniques?
- In case items do not fit the scale: should one adapt the measurement instrument by omitting items, or rather ensure comparability with other (uses of the) measurement instrument(s)?
- In the case of (too) small subgroups: should one drop the hypothesis about inter-group differences, or use small sample techniques, like exact tests or http://en.wikipedia.org/wiki/Bootstrapping _%28statistics%29" \o"Bootstrapping (statistics)"?
- In case the http://en.wikipedia.org/wiki/Randomization" \o "Randomization" procedure seems to be defective: can and should one calculate http://en.wikipedia.org/wiki/Propensity_score" \o "Propensity score" and include them as covariates in the main analyses?

3.4 Analysis

Several analyses can be used during the initial data analysis phase:

- Univariate statistics
- Bivariate associations (correlations)
- Graphical techniques (scatter plots)

It is important to take the measurement levels of the variables into account for the analyses, as special statistical techniques are available for each level

3.4.1 Nominal and ordinal variables

- Frequency counts (numbers and percentages)
- Associations
  - circumambulations (crosstabulations)
  - hierarchical loglinear analysis (restricted to a maximum of 8 variables)
  - loglinear analysis (to identify relevant/important variables and possible confounders)
- Exact tests or bootstrapping (in case subgroups are small)
- Computation of new variables

3.4.2 Continuous variables

- Distribution
- Statistics (M, SD, variance, skewness, kurtosis)
- Stem-and-leaf displays
- Box plots

3.5 Main data analysis

In the main analysis phase analyses aimed at answering the research question are performed as well as any other relevant analysis needed to write the first draft of the research report.

3.5.1 Exploratory and confirmatory approaches

In the main analysis phase either an exploratory or confirmatory approach can be adopted. Usually the approach is decided before data is collected. In an exploratory analysis no clear hypothesis is stated before analysing the data, and the data is searched for models that describe the data well. In a confirmatory analysis clear hypotheses about the data are tested. http://en.wikipedia.org/wiki/Exploratory_data_analysis" \o "Exploratory data analysis" should be interpreted carefully. When testing multiple models at once there is a high chance on finding at least one of them to be significant, but this can be due to a http://en.wikipedia.org/wiki/Type_1_error" \o "Type 1 error". It is important to always adjust the significance level when testing multiple models with, for example, a http://en.wikipedia.org/wiki/Bonferroni_correction" \o "Bonferroni correction". Also, one should not follow up an exploratory analysis with a confirmatory analysis in the same dataset. An exploratory

analysis is used to find ideas for a theory, but not to test that theory as well. When a model is found exploratory in a dataset, then following up that analysis with a confirmatory analysis in the same dataset could simply mean that the results of the confirmatory analysis are due to the same http://en.wikipedia.org/wiki/Type_1_error" \o "Type 1 error" that resulted in the exploratory model in the first place. The confirmatory analysis therefore will not be more informative than the original exploratory analysis.

3.5.2 Stability of results

It is important to obtain some indication about how generalizable the results are. While this is hard to check, one can look at the stability of the results. Are the results reliable and reproducible? There are two main ways of doing this:

- http://en.wikipedia.org/wiki/Cross-validation_%28statistics%29" \o "Cross-validation (statistics)": By splitting the data in multiple parts we can check if analyzes (like a fitted model) based on one part of the data generalize to another part of the data as well.
- http://en.wikipedia.org/wiki/Sensitivity_analysis" \o "Sensitivity analysis": A procedure to study the behavior of a system or model when global parameters are (systematically) varied. One way to do this is with bootstrapping.

3.5.3 Statistical methods

A lot of statistical methods have been used for statistical analyses. A very brief list of four of the more popular methods is:

- http://en.wikipedia.org/wiki/General_linear_model" \o "General linear model": A widely used model on which various statistical methods are based (e.g. http://en.wikipedia.org/wiki/T_test" \o "T test", http://en.wikipedia.org/wiki/ANOVA" \o "ANOVA", http://en.wikipedia.org/wiki/ANCOVA" \o "ANCOVA", http://en.wikipedia.org/wiki/MANOVA" \o "MANOVA"). Usable for assessing the effect of several predictors on one or more continuous dependent variables.
- http://en.wikipedia.org/wiki/Generalized_linear_model" \o "Generalized linear model": An extension of the general linear model for discrete dependent variables.
- http://en.wikipedia.org/wiki/Structural_equation_modelling" \o "Structural equation modelling": Usable for assessing latent structures from measured manifest variables.
- http://en.wikipedia.org/wiki/Item_response_theory" \o "Item response theory": Models for (mostly) assessing one latent variable from several binary measured variables (e.g. an exam).

3.6 Analysis with Bar chart

A bar chart/bar graph is a chart with rectangular bars with lengths proportional to the values that they represent. The bars can be plotted vertically or horizontally. Bar charts are used for marking clear data which has learned values. A bar chart is very useful if we are trying to record certain information whether it is continuous or not continuous data. Bar charts also look a lot like a histogram. They are often mistaken for each other.

3.6.1 Bar chart analysis Result

Industry vs. Machine Breakdown
1. Minimum Value 0 minutes
2. Maximum Value 983.96 minutes
3. Mean Value (0-983.96) is 491.98
4. Number of industry above 491.98 is 4, below 27
5. Percent of Industry affected by Machine Breakdown

Table 1: Number of Industry affected by Machine Breakdown

	Number of Industry affected by Machine Breakdown			
Data Range	range	Number	percentage	
	0	4	12.90	
	001>100	4	12.90	
	100>200	10	32.26	
	200>300	7	22.58	
	300>400	2	6.45	
	400>500	0	0	
	500>600	0	0	
	600>700	0	0	
	700>800	1	3.23	
	800>900	1	3.23	
	900>1000	2	6.45	

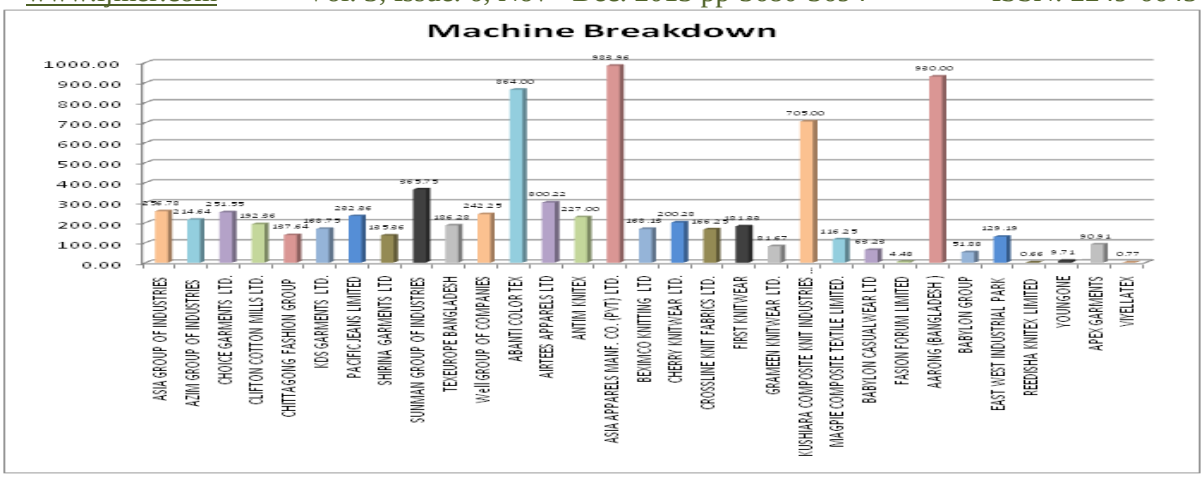

Figure 2: Industry Vs Machine Breakdown

3.6.2 Industry vs. Absenteeism Problem

1. Minimum Value 0 minutes
2. Maximum Value 1345.33 minutes
3. Mean Value (0-1345.33) is 672.665
4. Number of industry above 672.665 is 2, below 29
5. Percent of Industry affected by Absenteeism Problem

Table 2: Number of Industry affected by Absenteeism

	Number of Industry affected by Absenteeism			
Data Range	Range	Number	percentage	
	0.00	3	9.68	
	001>100	19	61.29	
	100>200	2	35.48	
	200>300	3	9.68	
	300>400	0	3.23	
	400>500	2	6.45	
	500>600	0	0	
	600>700	0	0	
	700>800	1	3.23	
	800>900	0	0	
	900>1000	0	0	
	1000>1100	0	0	
	1100>1200	0	0	
	1200>1300	0	0	
	1300>1400	1	3.23	

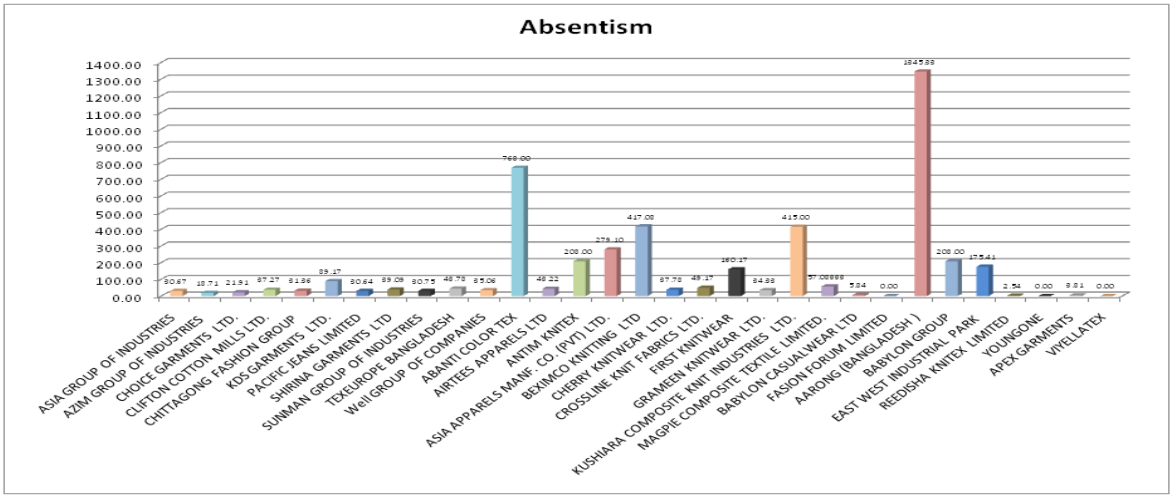

Figure 3: Industry Vs. Absenteeism

3.6.3 Industry Vs. No Input Problem

1. Minimum Value 0 minutes

2. Maximum Value 1029.17 minutes
3. Mean Value (0-1029.17) is 514.585
4. Number of industry above 514.585 is 4, below 27
5. Percent of Industry affected by No Input problem

Table 3: Number of Industry affected by No Input

	Number of Industry affected by No Input			
Data Range	Range	Number	percentage	
	0.00	1	3.22	
	001>100	17	54.84	
	100>200	3	9.68	
	200>300	3	9.68	
	300>400	3	9.68	
	400>500	0	0	
	500>600	1	3.23	
	600>700	0	0	
	700>800	1	3.23	
	800>900	0	0	
	900>1000	1	3.23	
	1000>1100	1	3.23	

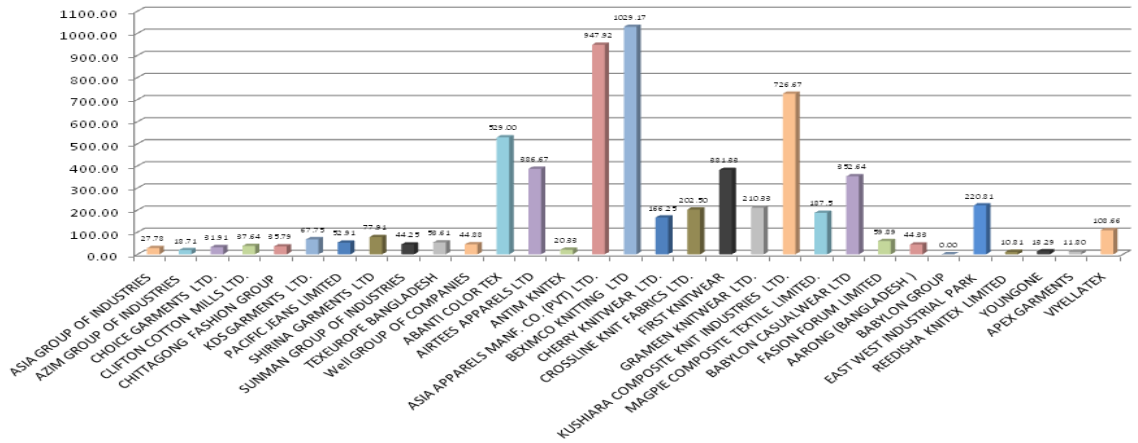

Figure 4: Industry vs. No Input

3.6.4 Industry vs. Quality

1. Minimum Value 0 minutes
2. Maximum Value 768.33 minutes
3. Mean Value (0-768.33) is 384.17
4. Number of industry above 384.17 is 1, below 30
5. Percent of Industry affected by Quality

Table 4: Number of Industry affected by quality problem

	Number of Industry affected by quality problem			
Data Range	Range	Number	percentage	
	0.00	4	9.68	
	001>100	9	48.39	
	100>200	11	9.68	
	200>300	6	9.68	
	300>400	1	9.68	
	400>500	0	0	
	500>600	0	3.23	
	600>700	0	0	
	700>800	1	3.23	

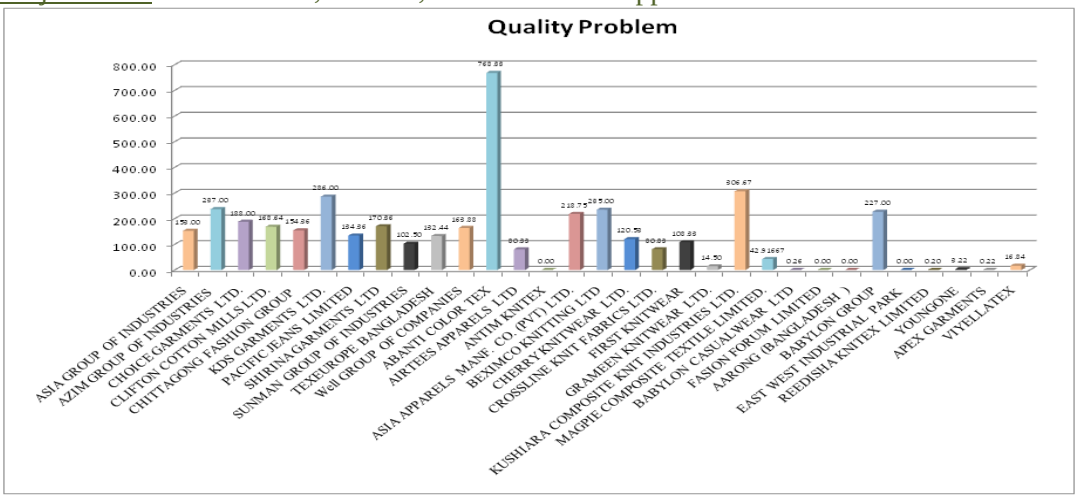

Figure 5: Industry Vs. quality problem

3.6.5 Industry vs. Miscellaneous

1. Minimum Value 0 minutes
2. Maximum Value 251.74 minutes
3. Mean Value (0-251.74) is 125.87
4. Number of industry above 125.87 is 3, below 28
5. Percent of Industry affected by Miscellaneous Problem

Table 5: Number of Industry affected by Miscellaneous

	Number of Industry affected by Miscellaneous			
Data Range	Range	Number	percentage	
	0.00	4	12.90	
	0.0>20	7	22.58	
	20>40	8	25.80	
	40>60	4	12.90	
	60>80	3	9.68	
	80>100	0	0	
	100>120	2	6.45	
	120>140	2	6.45	
	140>160	0	0	
	160>180	0	0	
	180>200	0	0	
	200>220	0	0	
	220>240	0	0	
	240>260	1	3.22	

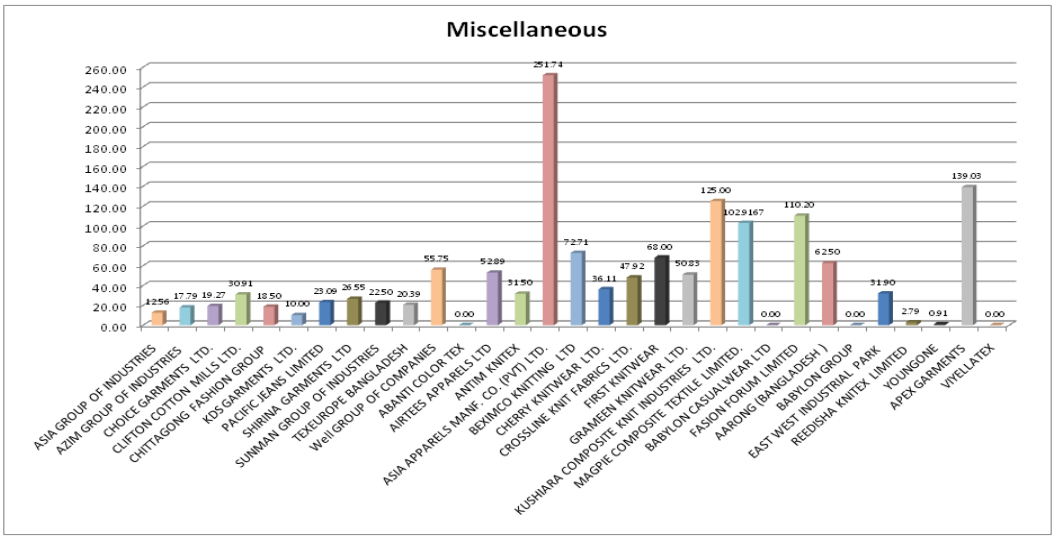

Figure 6: Industry vs. Miscellaneous

3.7 .Descriptive Statistics

Mean: Sum of all of the numbers in the set and divide by how many numbers are in the list is known as mean

Median: A median is described as the numerical value separating the higher half of a sample, a population, or a probability distribution, from the lower half.

Mode: The mode is the value that occurs most frequently in a data set or a probability distribution

Standard deviation: Standard deviation is a widely used measure of variability or diversity used in statistics and probability theory. It shows how much variation or "dispersion" there is from the average (mean, or expected value). A low standard deviation indicates that the data points tend to be very close to the mean, whereas high standard deviation indicates that the data points are spread out over a large range of values.

Variance: The variance is a measure of how far a set of numbers is spread out

Table 6: Descriptive Statistics

Statistics

		MBreakdown	Quality	Absentism	NoInput	Miscellaneous
N	Valid	31	31	31	31	31
	Missing	0	0	0	0	0
Mean		247.0496774	132.7247313	148.9765590	196.8722581	46.5889258
Std. Error of Mean		47.13554260	27.14853373	49.81264826	48.89687767	9.62216399
Median		181.3300000	120.5300000	37.7800000	59.8900000	30.9100000
Mode		.66000[a]	.00000	.00000	.00000[a]	.00000
Std. Deviation		2.62439594E2	1.51156639E2	2.77345088E2	2.72246293E2	53.57394177
Variance		68874.541	22848.329	76920.298	74118.044	2870.167
Range		983.30000	768.33000	1345.33000	1029.17000	251.74000
Minimum		.66000	.00000	.00000	.00000	.00000
Maximum		983.96000	768.33000	1345.33000	1029.17000	251.74000
Sum		7658.54000	4114.46667	4618.27333	6103.04000	1444.25670

3.8 Analysis with Histogram

Histogram is a graphical representation showing a visual impression of the distribution of data. It is an estimate of the http://en.wikipedia.org/wiki/Probability_distribution" \o "Probability distribution" of a continuous variable A histogram consists of tabular http://en.wikipedia.org/wiki/Frequency_%28statistics%29" \o "Frequency (statistics)", shown as adjacent http://en.wikipedia.org/wiki/Rectangle" \o "Rectangle", erected over discrete intervals (bins), with an area equal to the frequency of the observations in the interval. The height of a rectangle is also equal to the frequency density of the interval.

Table 7: Machine breakdown Analysis Result

Down Time ranges (minutes)	Frequency (industry)
0-100	8
100-200	10
200-300	7
300-400	2
400-500	0
500-600	0
600-700	0
700-800	1
800-900	1
900-1000	2
Total	31

Table 8: Quality Problem Analysis Result

Down Time ranges (minutes)	Frequency (industry)
0-100	13
100-200	11
200-300	5
300-400	1
400-500	0
500-600	0
600-700	0
700-800	1
Total	31

Table 9: Absenteeism Analysis Result

Table 10: No Input Analysis Result

Down Time ranges (minutes)	Frequency (industry)
0-200	24
200-400	3
400-600	2
600-800	1
800-1000	0
1000-1200	0
1200-1400	1
Total	31

Down Time ranges (minutes)	Frequency (industry)
0-100	18
100-200	3
200-300	3
300-400	3
400-500	0
500-600	1
600-700	0
700-800	1
800-900	1
900-1000	1
1000-1200	0
Total	31

Table 11: Miscellaneous Analysis Result

Down Time ranges (minutes)	Frequency (industry)
0-25	14
25-50	6
50-75	6
75-100	0
100-125	2
125-150	2
150-175	0
175-200	0
200-225	0
225-250	0
250-275	1
275-300	0
Total	31

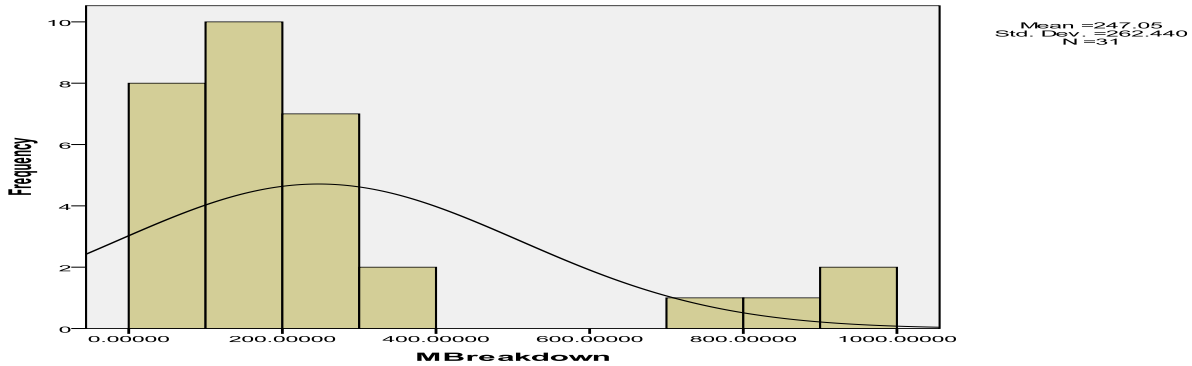

Figure 7: histogram (machine breakdown Vs frequency)

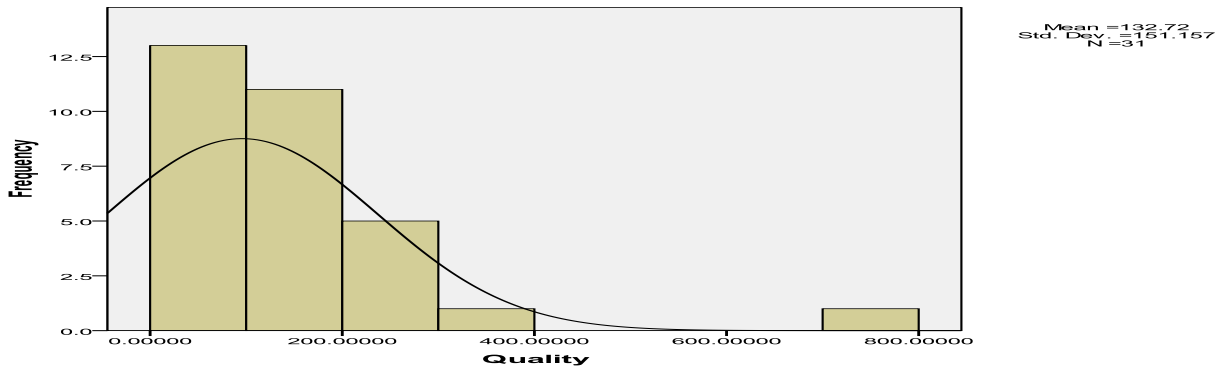

Figure 8: histogram (quality vs frequency)

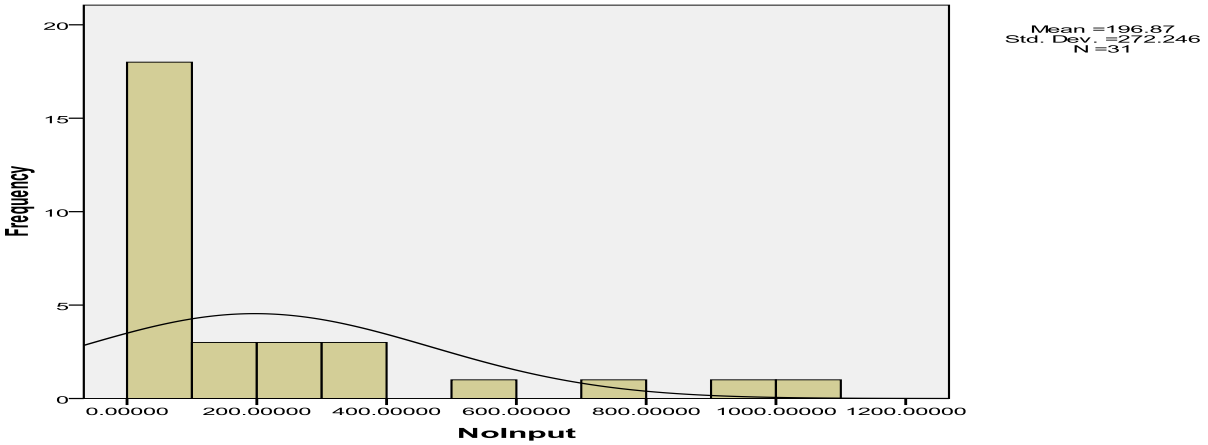

Figure 9: histogram (no input vs frequency)

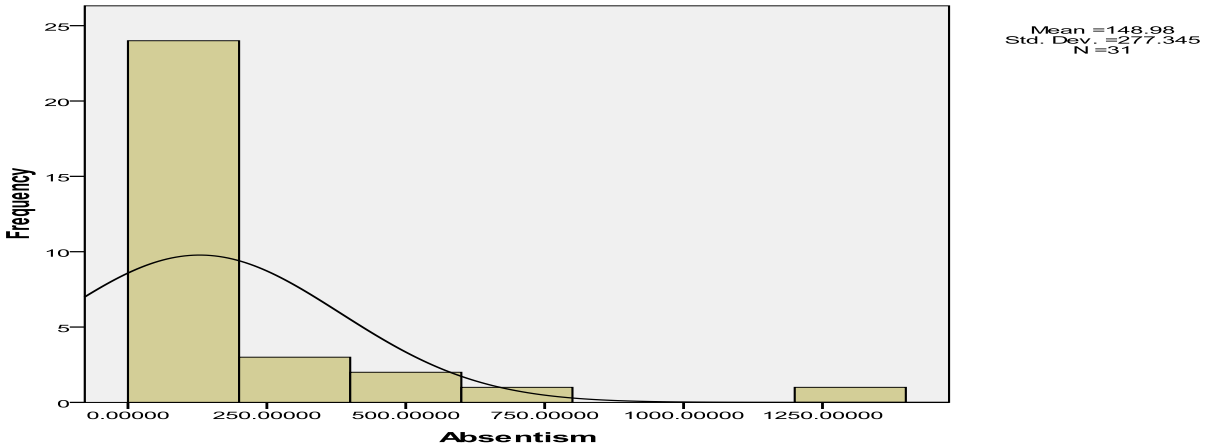

Figure 10: histogram (absenteeism vs frequency)

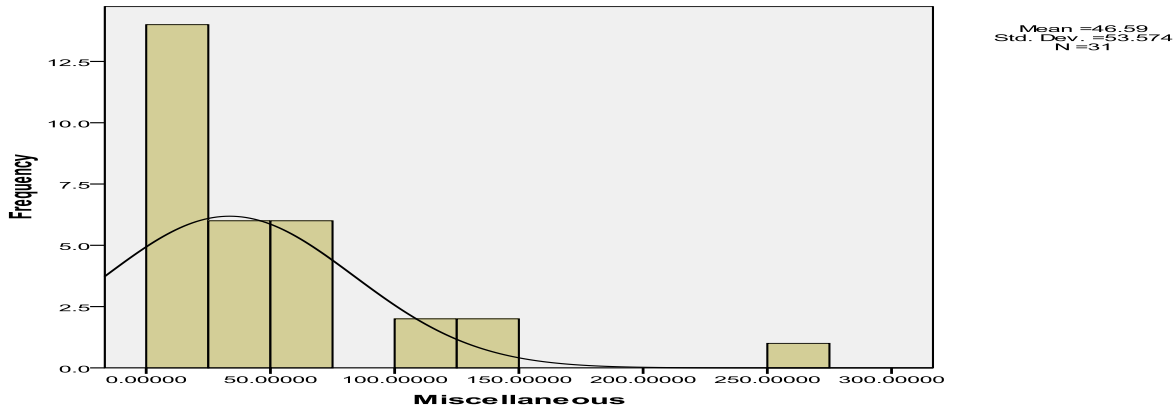

Figure 11: histogram (miscellaneous Vs frequency)

3.9 Analysis with Scatter Diagram

A scatter plot or scatter graph is a type of http://en.wikipedia.org/wiki/Mathematical_diagram" \o "Mathematical diagram" using http://en.wikipedia.org/wiki/Cartesian_coordinate_system" \o "Cartesian coordinate system" to display values for two http://en.wikipedia.org/wiki/Variable_%28mathematics%29" \o "Variable (mathematics)" for a set of data. The data is displayed as a collection of points, each having the value of one variable determining the position on the horizontal axis and the value of the other variable determining the position on the vertical axis. This kind of http://en.wikipedia.org/wiki/Plot_%28graphics%29" \o "Plot (graphics)" is also called a *scatter chart*, *scatter gram*, *scatter diagram* or *scatter graph*.

Table 12: Continuity Test

Downtime Type	Dispersion much	Points Continuous Except
Machine Breakdown	SUNMAN GROUP OF INDUSTRIES ABANTI COLOR TEX http://www.bkmea.com/member/member_details.php?BackSearch&Page=5&MID=1161 MAGPIE COMPOSITE TEXTILE LIMITED	SUNMAN GROUP OF INDUSTRIES ABANTI COLOR TEX http://www.bkmea.com/member/member_details.php?BackSearch&Page=5&MID=1161 MAGPIE COMPOSITE TEXTILE LIMITED
Quality Problem	SUNMAN GROUP OF INDUSTRIES	SUNMAN GROUP OF INDUSTRIES
Absenteeism	Aarong Bangladesh Limited	SUNMAN GROUP OF INDUSTRIES MAGPIE COMPOSITE TEXTILE LIMITED
No input	ABANTI COLOR TEX http://www.bkmea.com/member/member_details.php?BackSearch&Page=1&MID=327 http://www.bkmea.com/member/member_details.php?BackSearch&Page=5&MID=1161	http://www.bkmea.com/member/member_details.php?BackSearch&Page=1&MID=327 ANTIM KNITEX http://www.bkmea.com/member/member_details.php?BackSearch&Page=5&MID=1161
Miscellaneous	No	No

Table 13: Scatter condition

	Number of Industry(Frequency)	
Data ranges(minutes)	No.of point	Percent
0-200	117	75.48
200-400	25	16.13
400-600	3	1.94
600-800	4	2.58
800-1000	5	3.22
1000-1200	0	0
1200-1400	1	.65
Total	155	100

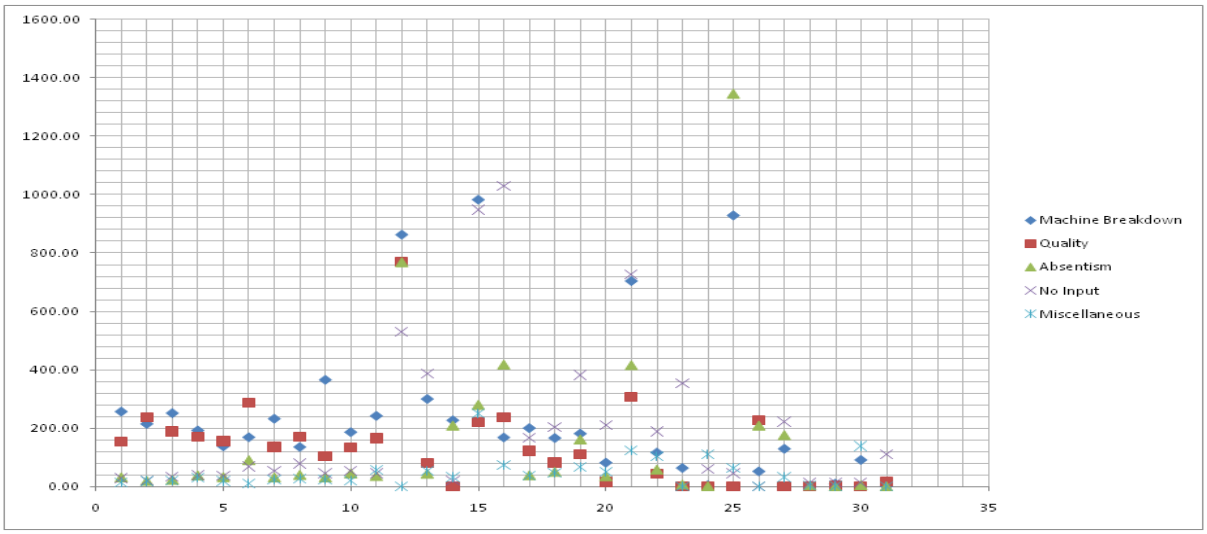

Figure 12: Scatter diagram (industry vs. five downtime)

3.10 Analysis with Line Chart

A line chart or line graph is a type of http://en.wikipedia.org/wiki/Graph_of_a_function" \o "Graph of a function", which displays information as a series of data points connected by straight http://en.wiktionary.org/wiki/line"\o"wikt:line" segments. http://en.wikipedia.org/wiki/Line_chart"\l "cite_note-0" It is a basic type of http://en.wikipedia.org/wiki/Chart" \o "Chart" common in many fields. It is an extension of an http://en.wikipedia.org/wiki/Scatter_graph" \o "Scatter graph", and is created by connecting a series of points that represent individual measurements with line segments. A line chart is often used to visualize a trend in data over intervals of time – a http://en.wikipedia.org/wiki/Time_series" \o "Time series" – thus the line is often drawn chronologically

3.10.1 Line Chart analysis Result

1. Continuity of data in downtime exist in - Asia Group Of Industries, Azim Group Of Industries, Choice Garments Ltd., Clifton Cotton Mills Ltd., Chittagong Fashion Group, Kds Garments Ltd., Pacific Jeans Limited, Shirina Garments Ltd, Sunman Group Of Industries, Texeurope Bangladesh, Well Group Of Companies
2. Abanti Color Tex has comparatively higher value in all five types downtime except Miscellaneous

Table 14: Downtime nature

Downtime Type	Maximum	Minimum
Machine Breakdown	http://www.bkmea.com/member/member_details.php?BackSearch&Page=2&MID=736	Viyellatex
Quality Problem	Abanti color Tex	Fasion Forum Limited,Antim Knitex, Fasion Forum Limited, Aarong (Bangladesh), East West Industrial Park
Absenteeism	Aarong Bangladesh Limited	Fasion Forum Limited, Youngone, Viyellatex
No input	http://www.bkmea.com/member/member_details.php?BackSearch&Page=3&MID=443	Babylon Group
Miscellaneous	http://www.bkmea.com/member/member_details.php?BackSearch&Page=2&MID=736	Abanti Color Tex, Babylon Casualwear Ltd, Babylon Group, Viyellatex

Table 15: Comparatively inferior organization

	Downtime				
	5	4	3	2	1
Abanti Color Tex	No		yes	No	No
http://www.bkmea.com/member/member_details.php?BackSearch&Page=2&MID=736	No	No	No	yes	No
http://www.bkmea.com/member/member_details.php?BackSearch&Page=3&MID=443	No	No	No	No	Yes (worse)
Kushiara Composite Knit Industries Ltd	No	No	No	yes	No
Aarong Bangladesh	No	No	No	Yes (worse)	No

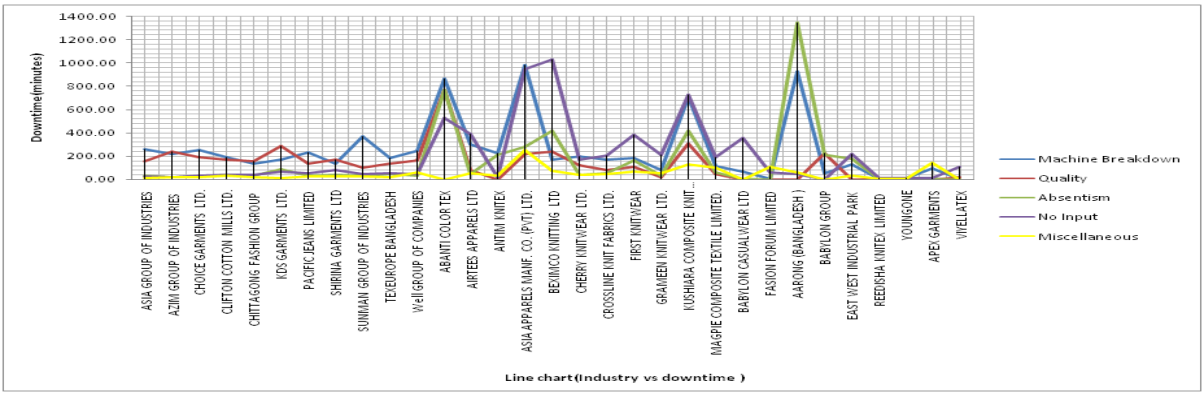

Figure 13: line chart (industry vs. downtime)

3.11 Analysis with proximity matrix correlation Distance

In http://en.wikipedia.org/wiki/Statistics" \o "Statistics" and in http://en.wikipedia.org/wiki/Probability_theory" \o "Probability theory", distance correlation is a measure of http://en.wikipedia.org/wiki/Statistical_dependence" \o "Statistical dependence" between two http://en.wikipedia .org/wiki/Random_variable" \o "Random variable" or two http://en.wikipedia.org/wiki/Random_vector" \o "Random vector" of arbitrary, not necessarily equal http://en.wikipedia.org/wiki/Euclidean_vector" \o "Euclidean vector". It's important property is that this measure of dependence is zero if and only if the http://en.wikipedia.org/wiki/Multivariate_random_variable" \o "Multivariate random variable" are http://en.wikipedia.org/wiki/Statistically_independent" \o "Statistically independent". This measure is derived from a number of other quantities that are used in its specification, specifically: distance variance, distance standard deviation and distance covariance.

3.11.1 Distances analysis Result

Proximity matrix depicts a clear correlation distances from one variable to another variable .By this way one variable is compared with another variable for feasibility test, further decision making & for comparative improvement.
From our proximity matrix we can easily compare one organization to another organization to identify how much it is affected by Machine Breakdown, Quality Problem, Absenteeism, No input, Miscellaneous and other down time problem .By this way organization can decide which problem they are affect most ,this problem needed to be minimized on an emergency basis. In below chart typical example of correlation Distance has been shown

Table 16: Machine Breakdown time comparison (Industry Vs Industry)

Industry name	Kds Garments Ltd.	Clifton Cotton Mills Ltd.	Viyellatex
Babylon Casualwear Ltd	105.5	129.1	129.1
Sunman Group Of Industries	197.0	197.0	365.0
Aarong (Bangladesh)	761.3	929.2	929.2

Table 17: Quality problem time comparison (Industry Vs Industry)

Industry name	Azim Group of Industries	http://www.bkmea.com/member/member_details.php?BackSearch&Page=5&MID=1161	Grameen Knitwear Ltd.
Antim Knitex	12.4	60.8	145.3
Shirina Garments Ltd	33.4	30.9	53.7
Babylon Group	162.8	114.4	29.8

Table 18: Absenteeism time comparison (Industry Vs Industry)

Industry name	East West Industrial Park	http://www.bkmea.com/member/member_details.php?BackSearch&Page=3&MID=443	Pacific Jeans Limited
Apex Garments	38.3	77.2	141.5
Grameen Knitwear Ltd.	47.5	86.5	150.7
Youngone	119.5	158.4	159.0

Table 19: No Input time comparison (Industry Vs Industry)

Industry name	http://www.bkmea.com/member/member_details.php?BackSearch&Page=4&MID=1078	http://www.bkmea.com/member/member_details.php?BackSearch&Page=2&MID=736	Viyellatex
Asia Group Of Industries	88.6	727.2	256.0
Chittagong Fashion Group	62.6	162.6	136.9
http://www.bkmea.com/member/member_details.php?BackSearch&Page=1&MID=327	99.9	683.7	299.5

Table 20: Miscellaneous problem time comparison (Industry Vs Industry)

Industry Name	Well Group of Companies	Texeurope Bangladesh	Choice Garments LTD.
Magpie Composite Textile Limited.	126.0	70.0	135.3
Fasion Forum Limited	237.8	181.9	247.1
Pacific Jeans Limited	9.9	46.1	19.2

IV. Conclusion

This study has extracted an overall scenario about the downtime, causes and their associated consequences in Ready-made Garments industry in Bangladesh. In order to gain a reasonable market share as well as to sustain in the present competitive market, it is necessary to improve the productivity level of the RMG sector. This will be possible if an organization can systematically identify and solve the reason not to create downtime. In the research five types of downtime were identified from whom quality and machine breakdown dominates other Problems. We found consequences for which companies have to pay a lot of money or time and the both are loss for industries. In the research, it is found that there is a chance to lose the goodwill of the company due to the loose relationship with the buyer. Other consequences are the increased delivery time, increased material wastage, increased time wastage and so on. So it is the time to minimize this problem not to give massive form of downtime and for this purpose the findings of this research can be used for benchmarking purpose to deal with daily occurred downtime in RMG sector. Further study can be conducted to verify the relationship between downtime and consequence to figure out monetary losses due to downtime.

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